

**What Is Claimed Is:**

1           1.       A method for computing interval parameter bounds from fallible  
2 measurements, comprising:  
3           receiving a set of measurements  $z_1, \dots, z_n$ , wherein an observation model  
4 describes each  $z_i$  as a function of a  $p$ -element vector parameter  $\mathbf{x} = (x_1, \dots, x_p)$ ;  
5           storing the set of measurements  $z_1, \dots, z_n$  in a memory in a computer  
6 system;  
7           forming a system of nonlinear equations  $z_i - h(\mathbf{x}) = 0$  ( $i=1, \dots, n$ ) based on  
8 the observation model; and  
9           solving the system of nonlinear equations to determine interval parameter  
10 bounds on  $\mathbf{x}$ .

1           2.       The method of claim 1, wherein the system of nonlinear equations  
2 is an "overdetermined system" in which there are more equations than unknowns.

1           3.       The method of claim 1, wherein each measurement  $z_i$  is actually a  
2  $q$ -element vector of measurements  $\mathbf{z}_i = (z_{i1}, \dots, z_{iq})^T$ , and  $h$  is actually a  $q$ -element  
3 vector of functions  $\mathbf{h} = (h_1, \dots, h_q)^T$ .

1           4.       The method of claim 1,  
2 wherein receiving the set of measurements involves receiving values for a  
3 set of conditions  $c_1, \dots, c_n$  under which the corresponding observations  $z_i$  were  
4 made; and  
5 wherein equations in the system of nonlinear equations account for the  
6 conditions  $c_i$  and are of the form  $z_i - h(\mathbf{x} | c_i) = 0$  ( $i=1, \dots, n$ ).

1           5.       The method of claim 4, wherein each condition  $c_i$  is actually an  $r$ -  
2 element vector of conditions  $\mathbf{c}_i = (c_{i1}, \dots, c_{ir})^T$ .

1           6.       The method of claim 4, wherein each condition  $c_i$  is not known  
2 precisely but is contained within an interval  $c_i^l$ .

1           7.       The method of claim 4, wherein equations in the system of  
2 nonlinear equations are of the form  $z_i - h(\mathbf{x} | c_i) + \varepsilon^l(\mathbf{x}, c_i) = 0$  ( $i=1, \dots, n$ ), which  
3 includes an error model  $\varepsilon^l(\mathbf{x}, c_i)$  that provides interval bounds on measurement  
4 errors for  $z_i$ .

1           8.       The method of claim 7, wherein if  $z_i$  is actually a  $q$ -element vector  
2 of measurements  $\mathbf{z}_i = (z_{i1}, \dots, z_{iq})^T$ , then  $\varepsilon^l$  is actually a  $q$ -element vector  
3  $\boldsymbol{\varepsilon}^l = (\varepsilon_1, \dots, \varepsilon_q)^T$ .

1           9.       The method of claim 7, wherein if there exists no solution to the  
2 system of nonlinear equations, the method further comprises determining that at  
3 least one of the following is true:  
4           at least one of the set of measurements  $z_1, \dots, z_n$  is faulty;  
5           the observation model  $h(\mathbf{x} | c_i)$  is false;  
6           the error model  $\varepsilon^l(\mathbf{x}, c_i)$  is false; and  
7           the computational system used to compute interval bounds on elements of  
8  $\mathbf{x}$  is flawed.

1           10.      The method of claim 1, wherein solving the system of nonlinear  
2 equations involves:

3 linearizing the system of nonlinear equations to form a corresponding  
4 system of linear equations; and  
5 solving the system of linear equations.

1 11. The method of claim 10, wherein solving the system of nonlinear  
2 equations involves using Gaussian Elimination.

1 12. A computer-readable storage medium storing instructions that  
2 when executed by a computer cause the computer to perform a method for  
3 computing interval parameter bounds from fallible measurements, the method  
4 comprising:

5 receiving a set of measurements  $z_1, \dots, z_n$ , wherein an observation model  
6 describes each  $z_i$  as a function of a  $p$ -element vector parameter  $\mathbf{x} = (x_1, \dots, x_p)$ ;

7 storing the set of measurements  $z_1, \dots, z_n$  in a memory in a computer  
8 system;

9 forming a system of nonlinear equations  $z_i - h(\mathbf{x}) = 0$  ( $i=1, \dots, n$ ) based on  
10 the observation model; and

11 solving the system of nonlinear equations to determine interval parameter  
12 bounds on  $\mathbf{x}$ .

1 13. The computer-readable storage medium of claim 12, wherein the  
2 system of nonlinear equations is an "overdetermined system" in which there are  
3 more equations than unknowns.

1 14. The computer-readable storage medium of claim 12, wherein each  
2 measurement  $z_i$  is actually a  $q$ -element vector of measurements  $\mathbf{z}_i = (z_{i1}, \dots, z_{iq})^T$ ,  
3 and  $h$  is actually a  $q$ -element vector of functions  $\mathbf{h} = (h_1, \dots, h_q)^T$ .

1           15.     The computer-readable storage medium of claim 12,  
2                 wherein receiving the set of measurements involves receiving values for a  
3     set of conditions  $c_1, \dots, c_n$  under which the corresponding observations  $z_i$  were  
4     made; and  
5                 wherein equations in the system of nonlinear equations account for the  
6     conditions  $c_i$  and are of the form  $z_i - h(\mathbf{x} \mid c_i) = 0$  ( $i=1, \dots, n$ ).

1           16.     The computer-readable storage medium of claim 15, wherein each  
2     condition  $c_i$  is actually an  $r$ -element vector of conditions  $\mathbf{c}_i = (c_{i1}, \dots, c_{ir})^T$ .

1           17.     The computer-readable storage medium of claim 15, wherein each  
2     condition  $c_i$  is not known precisely but is contained within an interval  $c_i^l$ .

1           18.     The computer-readable storage medium of claim 15, wherein  
2     equations in the system of nonlinear equations are of the form,  
3      $z_i - h(\mathbf{x} \mid c_i) + \varepsilon^l(\mathbf{x}, c_i) = 0$  ( $i=1, \dots, n$ ), which includes an error model  $\varepsilon^l(\mathbf{x}, c_i)$  that  
4     provides interval bounds on measurement errors for  $z_i$ .

1           19.     The computer-readable storage medium of claim 18, wherein if  $z_i$   
2     is actually a  $q$ -element vector of measurements  $\mathbf{z}_i = (z_{i1}, \dots, z_{iq})^T$ , then  $\varepsilon^l$  is  
3     actually a  $q$ -element vector  $\boldsymbol{\varepsilon}^l = (\varepsilon_1, \dots, \varepsilon_q)^T$ .

1           20.     The computer-readable storage medium of claim 18, wherein if  
2     there exists no solution to the system of nonlinear equations, the method further  
3     comprises determining that at least one of the following is true:  
4                 at least one of the set of measurements  $z_i, \dots, z_n$  is faulty;

5 the observation model  $h(\mathbf{x} \mid c_i)$  is false;  
6 the error model  $\varepsilon^1(\mathbf{x}, c_i)$  is false; and  
7 the computational system used to compute interval bounds on elements of  
8  $\mathbf{x}$  is flawed.

1 21. The computer-readable storage medium of claim 12, wherein  
2 solving the system of nonlinear equations involves:  
3 linearizing the system of nonlinear equations to form a corresponding  
4 system of linear equations; and  
5 solving the system of linear equations.

1 22. The computer-readable storage medium of claim 21, wherein  
2 solving the system of nonlinear equations involves using Gaussian Elimination.

1 23. An apparatus that computes interval parameter bounds from  
2 fallible measurements, comprising:  
3 a receiving mechanism configured to receive a set of measurements  
4  $z_1, \dots, z_n$ , wherein an observation model describes each  $z_i$  as a function of a  
5  $p$ -element vector parameter  $\mathbf{x} = (x_1, \dots, x_p)$ ;  
6 a memory in a computer system for storing the set of measurements  
7  $z_1, \dots, z_n$ ;  
8 an equation forming mechanism configured to form a system of nonlinear  
9 equations  $z_i - h(\mathbf{x}) = 0$  ( $i=1, \dots, n$ ) based on the observation model; and  
10 a solver configured to solve the system of nonlinear equations to determine  
11 interval parameter bounds on  $\mathbf{x}$ .

- 1           24.     The apparatus of claim 23, wherein the system of nonlinear  
2 equations is an “overdetermined system” in which there are more equations than  
3 unknowns.
- 1           25.     The apparatus of claim 23, wherein each measurement  $z_i$  is actually  
2 a  $q$ -element vector of measurements  $\mathbf{z}_i = (z_{i1}, \dots, z_{iq})^T$ , and  $h$  is actually a  $q$ -  
3 element vector of functions  $\mathbf{h} = (h_1, \dots, h_q)^T$ .
- 1           26.     The apparatus of claim 23,  
2 wherein the receiving mechanism is additionally configured to receive  
3 values for a set of conditions  $c_1, \dots, c_n$  under which the corresponding  
4 observations  $z_i$  were made; and  
5 wherein equations in the system of nonlinear equations account for the  
6 conditions  $c_i$  and are of the form  $z_i - h(\mathbf{x} | c_i) = 0$  ( $i=1, \dots, n$ ).
- 1           27.     The apparatus of claim 26, wherein each condition  $c_i$  is actually an  
2  $r$ -element vector of conditions  $\mathbf{c}_i = (c_{i1}, \dots, c_{ir})^T$ .
- 1           28.     The apparatus of claim 26, wherein each condition  $c_i$  is not known  
2 precisely but is contained within an interval  $c_i^l$ .
- 1           29.     The apparatus of claim 26, wherein equations in the system of  
2 nonlinear equations are of the form  $z_i - h(\mathbf{x} | c_i) + \varepsilon^l(\mathbf{x}, c_i) = 0$  ( $i=1, \dots, n$ ), which  
3 includes an error model  $\varepsilon^l(\mathbf{x}, c_i)$  that provides interval bounds on measurement  
4 errors for  $z_i$ .

1           30.    The apparatus of claim 29, wherein if  $z_i$  is actually a  $q$ -element  
2 vector of measurements  $z_i = (z_{i1}, \dots, z_{iq})^T$ , then  $\varepsilon^I$  is actually a  $q$ -element vector  
3  $\varepsilon^I = (\varepsilon_1, \dots, \varepsilon_q)^T$ .

1           31.    The apparatus of claim 29, wherein if there exists no solution to the  
2 system of nonlinear equations, the solver is configured to determine that at least  
3 one of the following is true:  
4           at least one of the set of measurements  $z_i, \dots, z_n$  is faulty;  
5           the observation model  $h(\mathbf{x} \mid c_i)$  is false;  
6           the error model  $\varepsilon^I(\mathbf{x}, c_i)$  is false; and  
7           the computational system used to compute interval bounds on elements of  
8  $\mathbf{x}$  is flawed.

1           32.    The apparatus of claim 23, wherein the solver is configured to:  
2           linearize the system of nonlinear equations to form a corresponding system  
3 of linear equations; and to  
4           solve the system of linear equations.

1           33.    The apparatus of claim 32, wherein the solver is configured to  
2 solve the system of nonlinear equations using Gaussian Elimination.